

Prepared for:  
**Sithe Global**  
Houston, TX



# Desert Rock Energy Facility: Class I Area Modeling Supplement

ENSR Corporation  
March 2006  
Document No.: 10784-001-0004

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## Draft

A handwritten signature in black ink, appearing to read "Jeffrey A. Connors".

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Prepared By: Jeffrey A. Connors

A handwritten signature in black ink, appearing to read "Robert J. Paine".

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Reviewed By: Robert J. Paine, QEP, CCM

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# 1.0 Introduction

## 1.1 Background

A Class I area modeling update to the Desert Rock Energy Facility (DREF) application for a Prevention of Significant Deterioration (PSD) permit was provided to agency reviewers on January 20, 2006. In Section 4 of the modeling report, ENSR provided a description of the expected large emission reductions from two coal-fired power plants in the area: the Four Corners Power Plant (FCPP) and the San Juan Generating Station (SJGS). These emission reductions are not required to show compliance with the National Ambient Air Quality Standards or PSD increments, and they are much larger (for SO<sub>2</sub>) than the emissions from the proposed project.

The National Park Service has asked the applicant to provide a more quantitative estimate of the potential regional haze benefits of these planned emission reductions, especially in view of the beginning phase of the implementation of the Regional Haze Rule (RHR). This analysis focuses upon the expected change in regional haze impacts from the FCPP, SJGS, and the proposed DREF between the dates of the RHR baseline period (2000-2004) and 2010 (or shortly thereafter). This future period is selected because the emission reductions from the FCPP and the SJGS are expected to be fully implemented, and the DREF will not be operational prior to 2010. The modeling has been done using the full-year meteorological data for 2001-2003 that was based on the 36 and 12-km MM5 data and used for the recently submitted modeling update.

## 1.2 Organization of the report

Section 2 describes the emissions data and modeling procedures used in the analysis of the baseline and future emissions. Section 3 discusses the metrics used to determine the RHR progress in the near future from the emission changes discussed in Section 2. The modeling results are reported in Section 4, and an interpretation of the changes in impacts and conclusions are presented in Section 5.

## 2.0 Emissions estimates and modeling procedures

Consistent with EPA's tracking of progress toward RHR goals, the emissions modeled for the RHR baseline period were annual average emissions for actual hours of operation for the 5 units of the FCPP and the 4 units of the SJGS. Emissions of SO<sub>2</sub> and NO<sub>x</sub> are available from the EPA Acid Markets database. Emissions of PM<sub>10</sub> are not available in this database, but filterable PM<sub>10</sub> emissions data were available from the 1999 National Emissions Inventory (NEI). The condensable emissions were determined from guidance provided by Don Shepherd of the National Park Service.

For the baseline period modeling, we are using the 2000-2004 average emissions for operating hours for FCPP and SJGS. The emissions for SO<sub>2</sub> and NO<sub>x</sub> are provided from the EPA Acid Markets database. The data for PM<sub>10</sub> filterable emissions is available in the 1999 NEI (the latest data that we could reasonably find). We took the heat input from the 1999 EPA Acid Markets database to get a lb/MMBtu value, which we used for 2000-2004 since we know of no changes to PM filterable controls during that time. This approach is consistent with that requested by the National Park Service.

For the period of 2010 and beyond, we modeled permitted emissions from DREF plus emissions with planned controls for FCPP and SJGS. For FCPP, we assumed no decrease in NO<sub>x</sub> or PM<sub>10</sub> emissions (although controls related to SO<sub>2</sub> decreases could result in lower H<sub>2</sub>SO<sub>4</sub> emissions, so this is a conservative assessment in that regard). We assumed 88% SO<sub>2</sub> control for FCPP, as noted in a communication from the Navajo Nation regarding a Title V annual permit limit (see Appendix A). We took the ratio of the SO<sub>2</sub> emissions from 2000-2004 to those in the future by taking the average percentage of SO<sub>2</sub> control in 2000-2004, computed from the lb/MMBtu emitted and the lb/MMBtu in the coal delivered, from the BHP data provided in Appendix B. The BHP data are also provided in a spreadsheet included in the modeling archive for the convenience of the reviewers.

For SJGS, we assumed 90% SO<sub>2</sub> control on an annual basis, consistent with the consent decree found in Appendix C. The 90% controls are associated with annual averages, which is consistent with the averages used for the baseline emissions calculations. For the future emission rates, we used the same type of ratio calculation as was done for FCPP, described above. For NO<sub>x</sub> at SJGS, we are assuming a 30-day limit of 0.30 lb/MMBtu which is a conservative assessment compared to the annual limit used for the baseline modeling.

The current electrostatic precipitator controls for each of the SJGS units will be replaced by fabric filter controls by the year 2010. Information available at [http://www.pnm.com/news/docs/2005/0310\\_sj\\_particulates.pdf](http://www.pnm.com/news/docs/2005/0310_sj_particulates.pdf) indicates that these emission control improvements will reduce PM<sub>10</sub> emissions by 70%. For PM<sub>10</sub> emissions at SJGS, we are aware of a consent decree upper limit of 0.015 lb/MMBtu for filterable PM<sub>10</sub>. In the baseline period, some of the units actually had emissions below that rate on an annual basis, and some had higher emissions. A realistic modeling approach would be to take a 70% reduction from the 2000-2004 PM<sub>10</sub> emissions for the future. However, to be extremely conservative, we have used the consent decree emissions as an upper limit. We are sure that the installation of controls will not increase the emissions, so we took the following conservative approach.

1. We do not take credit for any emission reductions in the future if the baseline filterable PM<sub>10</sub> emission rate for a given unit is already below 0.015 lb/MMBtu - just persist this value.
2. However, if the baseline emission rate is above 0.015 lb/MMBtu, we assume a future rate at the consent decree value of 0.015 lb/MMBtu.

We know that this will significantly overstate the PM<sub>10</sub> emissions on an annual basis because the fabric filter controls are expected to provide an expected 70% reduction from current emission levels. Therefore, we may revisit this assumption, but we have decided to use this very conservative assessment for now.

For the condensable PM<sub>10</sub> emissions and speciation of total PM<sub>10</sub>, we have adopted the procedures provided by Don Shepherd of the National Park Service. This basically sets the condensable PM<sub>10</sub> emissions to twice the filterable emissions for units with fabric filter PM controls, and to 3.333 without a fabric filter control. For each case, the condensable PM<sub>10</sub> emissions were then subdivided as 80% H<sub>2</sub>SO<sub>4</sub> and 20% organic aerosols. The filterable PM<sub>10</sub> emissions were considered to be 96.3% inorganic fine particles and 3.7% elemental carbon.

We know from the EPA Acid Markets database that the utilization of each unit for FCPP and SJGS has been above 85% (the future WRAP assumption) during the baseline period; this information is provided in the modeling archive spreadsheet. Therefore, it is appropriate to assume no increase for the future. We are aware of increased electrical demand projected by WRAP, and this is why there is a need for the proposed DREF plant, which would deliver the needed power for less pollution per kilowatt-hour than would be the case if the plant were not built.

For the future sulfur-in-coal projections, the BHP-projected values are provided in Appendix B. According to BHP, these projections have a high degree of confidence. The delivered coal in practice has a reasonably steady sulfur content because it is being mined from several coal seams at the same time. The 2.2 lb SO<sub>2</sub>/MMBtu value that the National Park Service sought to have modeled is, in our view and also BHP's, an anomalous value that represents a short-term contract upper limit. That is, if such coal is delivered on a given day, then the power plants have to accept it, but it is likely to be an extreme case. Since we are dealing with annual averages in this modeling analysis, we treat this case as an outlier. It is evident that to provide the anticipated annual average coal characteristics, the BHP coal deliveries will sometimes have sulfur content above average and sometimes below average, but we are not accounting for the below average sulfur content in our modeling. The assumption of peak sulfur content for the entire year is not a credible scenario. It is also well known that flue gas desulfurization efficiencies increase with increased coal sulfur content, but no such increase in the removal rate is being assumed here, making the NPS scenario even more unrealistic.

To provide a realistic case in addition to the NPS case, we have modeled two future emission cases: (1) the expected long-term average coal qualities, that being the average between 2011 and 2016 (due to increases in these years over prior years, to be conservative) and (2) the 2.2 lb SO<sub>2</sub>/MMBtu value requested by the National Park Service. The results of these two runs are documented in Section 4 and compared to the baseline 2000-2004 case. We also note that it is possible to interpolate between these two limits to determine the likely results for other sulfur-in-coal assumptions that one may wish to make.

The modeling was conducted for all 15 Class I areas considered in previously submitted analyses for DREF alone, using the full-year databases for 2001-2003. Tables 2-1 and 2-2 summarize the pollutant emissions used to model FCPP and SJGS for the 2000-2004 baseline period along with the two projected future cases (computed as described above). Table 2-3 summarizes the stack parameters used in the modeling, which are expected to be virtually the same from the 2000-2004 baseline period to the future cases. Detailed emissions calculations can be found in Appendix D. DREF was modeled with the same emissions and stack parameters as provided in the January 20, 2006 submittal. It is worth noting that the 24-hour SO<sub>2</sub> emission rate was modeled for DREF, even though compliance with a short-term limit will always result in a lower actual annual average emission rate. The modeling was conducted using the larger 4-km grid that encompasses all Class I areas, as agreed upon with the National Park Service.

**Table 2-1 FCPP and SJGS 2000-2004 Baseline Modeled Emissions**

Facility	Unit	Period	Modeled Emission Rates (lbs/hr)							
			SO <sub>2</sub> <sup>(1)</sup>	NO <sub>x</sub> <sup>(1)</sup>	PM <sub>10</sub> Filt. <sup>(2)</sup>	PM <sub>10</sub> Cond. <sup>(3)</sup>	SO <sub>4</sub> <sup>(4)</sup>	Organic <sup>(4)</sup>	Carbon <sup>(4)</sup>	Soil <sup>(4)</sup>
Four Corners	1	2000-2004	744.43	1478.36	217.23	724.08	579.27	144.82	8.04	209.19
Four Corners	2	2000-2004	765.60	1145.57	230.34	767.78	614.23	153.56	8.52	221.81
Four Corners	3	2000-2004	989.15	1427.33	295.63	591.26	473.01	118.25	10.94	284.69
Four Corners	4	2000-2004	3028.91	3891.04	138.22	276.45	221.16	55.29	5.11	133.11
Four Corners	5	2000-2004	3068.99	3456.13	125.15	250.30	200.24	50.06	4.63	120.52
San Juan	1	2000-2004	884.03	1434.40	59.71	199.02	159.22	39.80	2.21	57.50
San Juan	2	2000-2004	848.06	1466.15	81.92	273.08	218.46	54.62	3.03	78.89
San Juan	3	2000-2004	1542.56	2080.82	71.89	239.64	191.71	47.93	2.66	69.23
San Juan	4	2000-2004	1624.74	2171.03	58.16	193.88	155.10	38.78	2.15	56.01
(1) Data obtained from EPA's Acid Rain Database.										
(2) Calculated using TPY emissions from 1999 NEI and 1999 Heat Input from EPA's Acid Rain Database.										
(3) Estimated from lb/MMBtu emissions as derived using 1999 NEI and 1999 EPA's Acid Rain heat input and 2000-2004 annual average heat input from EPA's Acid Rain database.										
(4) Estimated from lb/MMBtu emissions as derived using speciation workbook and 2000-2004 annual average heat input from EPA's Acid Rain database.										

**Table 2-2 FCPP and SJGS Future Modeled Emissions**

Facility	Unit	Year	Modeled Emission Rates (lbs/hr) <sup>(1,2)</sup>								
			Future <sup>(3)</sup> Avg. SO <sub>2</sub>	Peak SO <sub>2</sub>	NO <sub>x</sub> <sup>(4)</sup>	PM <sub>10</sub> Filt. <sup>(5)</sup>	PM <sub>10</sub> Cond.	SO <sub>4</sub>	Organic	Carbon	Soil
Four Corners	1	2010	410.61	491.90	1478.36	217.23	724.08	579.27	144.82	8.04	209.19
Four Corners	2	2010	421.56	505.02	1145.57	230.34	767.78	614.23	153.56	8.52	221.81
Four Corners	3	2010	533.59	639.24	1427.33	295.63	591.26	473.01	118.25	10.94	284.69
Four Corners	4	2010	1566.15	1876.22	3891.04	138.22	276.45	221.16	55.29	5.11	133.11
Four Corners	5	2010	1529.57	1832.39	3456.13	125.15	250.30	200.24	50.06	4.63	120.52
San Juan	1	2010	529.74	731.68	997.74	49.89	99.77	79.82	19.95	1.85	48.04
San Juan	2	2010	509.92	704.30	960.40	48.02	96.04	76.83	19.21	1.78	46.24
San Juan	3	2010	797.02	1100.84	1501.15	71.89	143.78	115.03	28.76	2.66	69.23
San Juan	4	2010	820.36	1133.08	1545.11	58.16	116.33	93.06	23.27	2.15	56.01
(1) For FCPP, calculated based on projected 88% control of SO <sub>2</sub> in 2010 versus 2000-2004 average % control of SO <sub>2</sub> .											
(2) For SJGS, calculated based on projected 90% control of SO <sub>2</sub> in 2010 versus 2000-2004 average % control of SO <sub>2</sub> .											
(3) Data provided by BHP (2011-2016 average coal sulfur content used, due to its higher values).											
(4) No change to FCPP emissions. SJGS reduced to 0.30 lb/MMtu.											
(5) No change to FCPP emissions. SJGS reduced to 0.015 lbs/MMBtu if baseline emissions where greater than 0.015 lb/MMBtu, otherwise emissions unchanged											

**Table 2-3 FCPP and SJGS Modeled Stack Parameters**

Name	Model ID	Lat	Long	Base El. (m)	Stack Height (m)	Stack Temp (K)	Exit Velocity (m/s)	Stack Diameter (m)
Four Corners Unit 1	4C1	36.69	-108.48	1615.0	76.20	327.59	18.29	5.36
Four Corners Unit 2	4C2	36.69	-108.48	1615.0	76.20	327.59	18.29	5.36
Four Corners Unit 3	4C3	36.69	-108.48	1615.0	76.20	327.59	31.63	4.36
Four Corners Unit 4	4C4	36.69	-108.48	1615.0	115.82	333.15	23.89	8.69
Four Corners Unit 5	4C5	36.69	-108.48	1615.0	115.82	333.15	18.29	8.69
San Juan Unit 1	SJGS1	36.80	-108.44	1614.9	121.92	317.59	18.29	6.096
San Juan Unit 2	SJGS2	36.80	-108.44	1614.9	121.92	317.59	18.29	6.096
San Juan Unit 3	SJGS3	36.80	-108.44	1614.9	121.92	322.04	15.85	8.534
San Juan Unit 4	SJGS4	36.80	-108.44	1614.9	121.92	322.04	15.85	8.534

### 3.0 Tracking progress under the Regional Haze Rule

The important metric for tracking progress under the RHR is the extinction associated with the best 20% days (10% ranked extinction is the midpoint value used for this metric) and, more importantly, the worst 20% days (90% ranked extinction is the midpoint used for this metric). We expect the 10% ranked modeled extinction to be low, or virtually zero (because the power plant plumes would be expected to miss the Class I areas at least 10% of the time), and the RHR basically indicates that the visibility for this metric should not degrade. This degradation is unlikely because the extinction for the worst 90% days has to be reduced. The goal of this exercise is therefore to show that the more important 90% ranked extinction statistic shows an improvement between the 2000-2004 baseline period and 2010 because the RHR indicates that extinction should be gradually reduced to natural background for this metric by 2064. The period from the baseline years to 2010 represents 10% of the 60-year RHR period, so we determined whether a modeled extinction reduction of at least 10%, on average, was realized between these dates. The 90% extinction statistics for the sources that were modeled were computed for the baseline emission runs and the 2010 emissions runs. The comparison of these statistics is reported for each of the 15 Class I areas in the next section.

The 2000-2004 baseline observed extinction values for the worst 20% visibility days were obtained from the VIEWS website for each Class I area. When VIEWS data was not available for a certain Class I area, the appropriate monitor was assigned. Table 3-1 lists the Class I areas and the respective monitor number selected for the analysis. The extinction values associated with natural conditions to be reached under the RHR by 2064 for each Class I area was obtained from Appendix B of the "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program". The extinction values associated with the 20% worst days for the 2000-2004 baseline period and 2064 natural conditions are listed in Table 3-1.

**Table 3-1 Class I Areas with IMPROVE Monitor Data**

Class I Areas	Monitor	Monitor Location		Baseline (2000-2004) non- Rayleigh Extinction ( $\text{Mm}^{-1}$ )	2064 RHR non- Rayleigh Extinction goal ( $\text{Mm}^{-1}$ )
		Lat	Long		
Arches NP	Canyonlands NP	38.783	-109.583	23.36	10.12
Bandelier NM	Bandelier NM	35.780	-106.266	28.26	10.18
Black Cany. Gunn. NM	Weminuche W	37.659	-107.800	20.55	10.26
Canyonlands NP	Canyonlands NP	38.459	-109.821	23.36	10.16
Capitol Reef NP	Capitol Reef NP	38.302	-111.293	19.40	10.20
Grand Canyon NP	Grand Canyon, Hance	35.973	-111.984	24.63	10.04
Great Sand Dunes NM	Great Sand Dunes NM	37.725	-105.519	28.50	10.34
La Garita W	Weminuche W	37.659	-107.800	20.55	10.26
Mesa Verde NP	Mesa Verde NP	37.198	-108.491	30.68	10.32
Pecos W	Wheeler Peak W	36.585	-105.452	22.07	10.22
Petrified Forest NP	Petrified Forest NP	35.078	-109.769	30.60	10.08
San Pedro Parks W	San Pedro Parks W	36.014	-106.845	21.03	10.20
Weminuche W	Weminuche W	37.659	-107.800	20.55	10.26
West Elk W	White River NF	39.154	-106.821	19.63	10.28
Wheeler Peak W	Wheeler Peak W	36.585	-105.452	22.07	10.28

## 4.0 CALPUFF modeling results

The CALPOST predicted daily extinction values for each of the three years modeling were sorted, and the 10% and 90% ranked values were averaged over the three years for further analysis.

Results for the 10% ranked extinction values were, as expected, zero or very close to zero for both the baseline and the future emissions cases at each Class I area. Since the objective of the RHR is to not degrade the visibility for the 20% best days, no further analysis is needed for this aspect of the RHR.

Results for the 90% ranked extinction values are shown in Table 4-1 for each Class I area. This table shows the predicted extinction due to the plants modeled and the change between the baseline and the 2010 period, which includes emissions from DREF.

In many cases, the magnitude of the predicted extinction from the plants modeled is much lower than the difference between the baseline and the RHR target. In such cases, it would be expected that other components such as forest fires, windblown dust, and other anthropogenic sources are contributing to most of the difference between the RHR natural conditions goal and the baseline extinction. For these cases, the future modeled cases still consistently have lower total visibility impacts than the baseline case, even though the overall impact of the modeled sources is low in general. However, for the Mesa Verde National Park, the predicted baseline impact from the FCPP and SJGS is a relatively large component of the total anthropogenic contribution to the total extinction, as expected.

Table 4-2 lists the average (over the three years modeled) of the percentage reduction in extinction due to emissions from FCPP, SJGS, and DREF between the baseline period and 2010. The reductions are always more than 10% (the reduction needed by 2010 for the RHR glide slope), and even exceed 20% for Mesa Verde for both means of estimating the future SO<sub>2</sub> emissions. The extinction values listed in Table 4-1 are plotted in Figure 4-1 as a series of bar graphs. These same bar graphs are shown geographically in Figure 4-2.

**Table 4-1 Modeled Extinctions for the 90% ranked days – Baseline and Future Cases**

Class I Area	Extinction Predictions for FCPP, SJGS, and DREF Modeling Cases ( $\text{Mm}^{-1}$ )			
	Present 2000-2004 Emissions	RHR Extinction Goal for 2010	Future 2011-2016 Average $\text{SO}_2$ Emissions	Future Short-Term Peak $\text{SO}_2$ Emissions
Arches NP	3.250	2.925	2.567	2.690
Bandelier NM	3.792	3.413	3.043	3.199
Black Cany. Gunn. NM	2.235	2.012	1.848	1.902
Canyonlands NP	5.046	4.541	4.199	4.357
Capitol Reef NP	1.914	1.723	1.610	1.650
Grand Canyon NP	0.514	0.463	0.429	0.440
Great Sand Dunes NM	1.808	1.627	1.509	1.556
La Garita W	2.144	1.930	1.807	1.849
Mesa Verde NP	12.561	11.305	9.505	9.924
Pecos W	2.791	2.512	2.280	2.389
Petrified Forest NP	0.938	0.844	0.723	0.764
San Pedro Parks W	6.208	5.587	5.148	5.268
Weminuche W	2.097	1.887	1.761	1.835
West Elk W	3.735	3.362	3.094	3.192
Wheeler Peak W	2.048	1.843	1.712	1.777
(1) Extinction values exclude Rayleigh scattering.				

**Table 4-2 Percent Change in 90% Ranked Modeled Extinction from the Baseline Case for Future Cases**

<b>Class I Area</b>	<b>Acronym in Figures</b>	<b>2000-2004 vs. 2010 goal</b>	<b>2000-2004 vs. 2011-2016 Avg. Coal Sulfur Content Modeled Result</b>	<b>2000-2004 vs. Peak Coal Sulfur Content Modeled Result</b>
Arches NP	"arch"	-10.0	-21.0	-17.2
Bandelier NM	"band"	-10.0	-19.8	-15.6
Black Cany. Gunn. NM	"blca"	-10.0	-17.3	-14.9
Canyonlands NP	"cany"	-10.0	-16.8	-13.7
Capitol Reef NP	"care"	-10.0	-15.9	-13.8
Grand Canyon NP	"grca"	-10.0	-16.5	-14.3
Great Sand Dunes NM	"grsa"	-10.0	-16.5	-13.9
La Garita W	"laga"	-10.0	-15.7	-13.7
Mesa Verde NP	"meve"	-10.0	-24.3	-21.0
Pecos W	"peco"	-10.0	-18.3	-14.4
Petrified Forest NP	"pefo"	-10.0	-22.9	-18.6
San Pedro Parks W	"sape"	-10.0	-17.1	-15.1
Weminuche W	"weel"	-10.0	-16.0	-12.5
West Elk W	"wemi"	-10.0	-17.1	-14.5
Wheeler Peak W	"whpe"	-10.0	-16.4	-13.2

**Figure 4-1 Modeled Extinctions for 90% Worst Day: 2000-2004 Modeled Baseline, 2010 Targeted Reduction, and 2010 Modeled Cases**

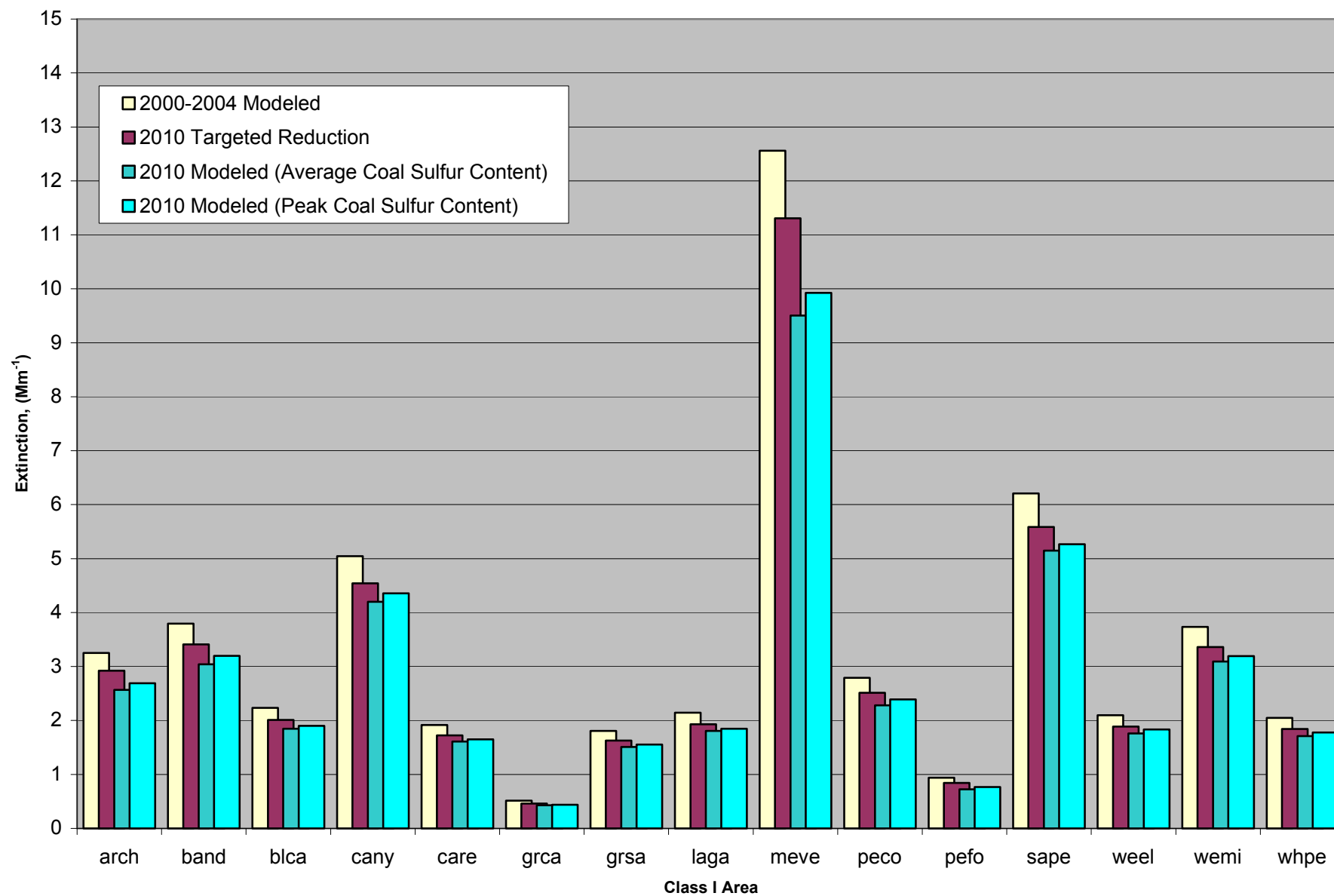
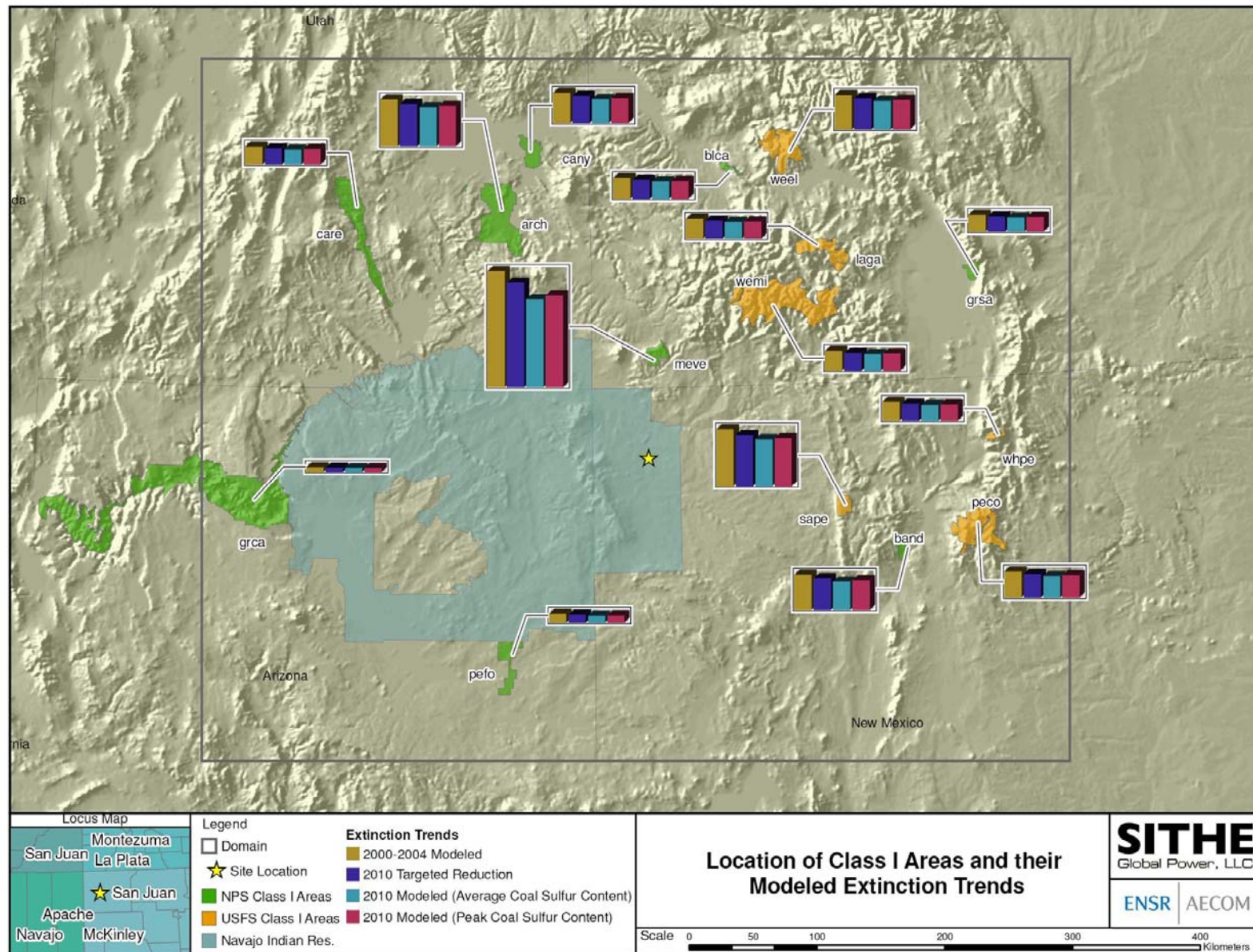


Figure 4-2 Location of Class I Areas and Modeled Extinction Trends



## 5.0 Interpretation of results and conclusions

The modeled results show that even with the conservative assumptions for future annual average emissions from FCPP, SJGS, and DREF, the predicted extinction values in 2010 that includes DREF emissions will satisfy the required progress for improvement in visibility required by the Regional Haze Rule. The predicted impact for the 10% ranked extinction for the sources modeled is at or near zero for the sources modeled. No degradation in the clean days is expected from the addition of emissions from DREF, which is more than offset by the emission reductions at FCPP and SJGS.

The predicted impact for the 90% ranked extinction due to future emissions from FCPP, SJGS, and DREF shows a decrease that is better than required by 2010 under the RHR (10% reduction), even for the outlier case of short-term peak sulfur content in the coal modeled at the request of the National Park Service. For the Mesa Verde National Park (the area most affected by the local emissions), the decrease by 2010 is over 20% from the baseline extinction for both cases of future SO<sub>2</sub> emissions.

We conclude that this analysis, even with its very conservative assumptions that artificially limited the benefits of the future emission reductions, shows that the operation of the proposed DREF will not adversely affect compliance with the goals of the Regional Haze Rule in the early part of the rule's implementation. The inclusion of more realistic emission reductions would result in even more beneficial visibility impact reductions, such as:

- possible improvements in the scrubbing efficiency at FCPP over 88% removal
- 70% reduction in the PM<sub>10</sub> emissions at SJGS
- Reductions in H<sub>2</sub>SO<sub>4</sub> emissions from the SO<sub>2</sub> controls
- Likely lower SO<sub>2</sub> emissions from DREF on an annual basis versus a daily basis.

## U.S. Locations

AK, Anchorage  
(907) 561-5700

AK, Fairbanks  
(907) 452-5700

AL, Birmingham  
(205) 980-0054

AL, Florence  
(256) 767-1210

CA, Alameda  
(510) 748-6700

CA, Camarillo  
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CA, Orange  
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CA, Sacramento  
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CO, Ft. Collins  
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Ft. Collins Tox Lab  
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CT, Stamford  
(203) 323-6620

CT, Willington  
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